REMARKS/ARGUMENT

Claims 21-24, and 26-41 are pending after entry of this Amendment. Claim 21 is herein amended to positively recite that the inorganic dielectric layer has a dielectric constant of about 4. Examiner is kindly directed to page 11, lines 6-10 of the specification as filed for support for the claim amendment to claim 21. Claim 41 is herein amended to positively recite that a via path is defined through an entire thickness of the inorganic dielectric layer and through a portion of the low dielectric constant layer. Examiner is kindly directed to Applicants' Figure 7, as well to page 13, line 20 through page 14, line 16 for support for the claim amendment to claim 41. No new matter is introduced.

Rejections under 35 U.S.C. §102

Claims 21-24, 26, and 36 were rejected under 35 U.S.C. §102(e) as being anticipated by Liu et al. (U.S. Patent No. 6,211,063). Applicants respectfully traverse this rejection and request reconsideration.

Liu et al. teach a method of fabricating an integrated circuit with dual damascene structures. The Liu et al. structure includes a substrate (30) with a first metal layer (32) in a silicon oxide layer (34) formed thereon. A first silicon oxynitride layer (35) is deposited overlying the first metal layer (32) and silicon oxide layer (34). A low-k value dielectric (36) of fluorinated silicate glass (FSG) is deposited over the first silicon oxynitride layer (35), and a second silicon oxynitride layer (38) is deposited over the low-k value FSG layer (36). The second silicon oxynitride layer (38) is patterned and etched for later feature (60) formation. A layer of hydrogen silsesquioxane (HSQ) (46) is deposited over the second silicon oxynitride layer (38), and a layer of plasma enhanced silicon dioxide (48) is deposited over the HSQ layer (46). A trench feature is first formed in the HSQ layer (46) (Figs. 7-8), and then a via feature is formed in the FSG layer (36) (Figs. 9-10).

As described and illustrated by Applicants, the present invention, in independent claim 21 as amended herein, claims a multi-layer dielectric layer over a substrate for use in dual-damascene applications. The multi-layer dielectric layer includes a barrier layer disposed over the substrate, an inorganic dielectric layer having a dielectric constant of about 4 disposed over the barrier layer, and a low dielectric constant layer disposed directly over the inorganic dielectric layer. The low

dielectric constant layer is configured to receive metallization line trenches and the inorganic dielectric layer is configured to receive vias during a dual-damascene process.

In independent claim 36, Applicants claim a dielectric structure for dual-damascene applications. The dielectric structure includes a barrier disposed over a base dielectric, an inorganic dielectric layer of a fluorine doped oxide disposed over the barrier, and a low dielectric constant layer of a carbon doped oxide disposed directly over the inorganic dielectric layer. The low dielectric constant layer is configured to receive metallization line trenches and the inorganic dielectric layer is configured to receive vias during a dual-damascene process.

To anticipate a claim, the reference must teach each and every element, either expressly or inherently, of the claim. See MPEP §2131. Applicants respectfully submit that the patent to Liu et al. fails to teach each and every element of Applicants' independent claims 21 and 36. Specifically, Liu et al. fail to teach a low dielectric constant layer disposed directly over an inorganic dielectric layer, fail to teach an inorganic dielectric layer disposed over a barrier layer, the inorganic dielectric layer having a dielectric constant of about 4, and fail to teach a low dielectric constant layer of a carbon-doped oxide disposed directly over an inorganic dielectric layer.

Liu et al. teach "HSQ is used as a dielectric material herein because of its low k-value (sic)" (col. 4, lines 50-51). HSQ therefore is a low dielectric constant layer, as Applicants have described in the instant application. Liu et al., however, also teach the deposition of a "second silicon oxynitride layer 38 [is] deposited overlying the FSG layer 36" (col. 4, lines 21-22), and therefore the HSQ layer *cannot* be disposed **directly** over the inorganic dielectric layer as claimed by Applicants. The structure claimed by Applicants does not include a barrier between the inorganic dielectric layer and the low dielectric constant layer, and does include the low dielectric constant layer disposed ***directly over*** the inorganic dielectric layer.

Liu et al. also teach that FSG is used for the layer that the Examiner corresponds to Applicants' inorganic dielectric layer because FSG has a low k value compared to other dielectrics such as silicon dioxide (col. 4, lines 17-19). Applicants have described the inorganic dielectric layer as an inorganic silicon dioxide (page 10, lines 21-22), having a dielectric constant of about 4 (page 11, line 10). Applicants have specifically differentiated between an inorganic silicon dioxide having a dielectric constant of about 4, and the low dielectric constant layer having a dielectric

constant of below about 3. Liu et al. are essentially teaching two low k layers, and are not teaching Applicants' claimed invention. Therefore, Liu et al. fail to teach each and every element of Applicants' independent claim 21, and Applicants respectfully request this rejection be withdrawn. Dependent claims 24-24 and 26, depending from independent claim 21, recite the same features which are not taught by Liu et al.

Further, in independent claim 36, Applicants claim a low dielectric constant layer of a carbon doped oxide disposed directly over the inorganic dielectric layer. Just as Liu et al. fail to teach one layer disposed directly over another, Liu et al. also fail to teach a low dielectric constant layer of a carbon doped oxide. HSQ is not a carbon doped oxide. Although the Examiner is correct in noting that Liu et al. state in the Summary of the Invention that a "layer of an organic spin-on hydrogen silsesquioxane (HSQ) is deposited overlying the second silicon oxynitride layer," (col. 3, lines 23-24) no further use of the term "organic" is associated with HSQ in the remainder of the patent. HSQ is clearly not organic in its chemical properties, and Liu et al. do not disclose or suggest a desirability to use an organic material as a low-k dielectric. With specific reference to the HSQ layer, Liu et al. fail to teach, or suggest, any organic material, carbon-doping, or other process or procedure to fabricate an organic quality or characteristic of the HSQ. The Examiner is particularly directed to col. 5, lines 17-32, of the reference where Liu et al. discuss the introduction of nitrogen gas to the standard chemistry and the resulting reactions. Carbon is integral to the reactions, and if, by way of example, a carbon-doped HSQ were to be used, the reactions and resulting polymer would be different than that described, and would be disclosed or suggested. They are not. While the term "organic" is used one time, and one time only, in the Summary of the Invention, HSQ is not an organic material, the use of the term "organic" is unclear and possibly in error, and no disclosure or suggestion of introduction of an organic quality is disclosed in the patent to Liu et al. Of course, even if it were, Liu et al. still fail to teach depositing a low dielectric constant layer of a carbon doped oxide directly over an inorganic dielectric layer. Liu et al. therefore fail to anticipate independent claim 36, and Applicants request the rejection be withdrawn.

Claims 21-23, and 26-27 were rejected under 35 U.S.C. §102(e) as being anticipated by Wang et al. (U.S. Patent No. 6,255,735). Applicants respectfully traverse this rejection and request reconsideration.

As described above, Applicants' independent claim 21, as amended herein, recites a multi-layer dielectric layer over a substrate for use in dual-damascene applications. The multi-layer dielectric layer includes a barrier layer disposed over the substrate, an inorganic dielectric layer having a dielectric constant of about 4 disposed over the barrier layer, and a low dielectric constant layer disposed directly over the inorganic dielectric layer. The low dielectric constant layer is configured to receive metallization line trenches and the inorganic dielectric layer is configured to receive vias during a dual-damascene process.

Wang et al. disclose a conductive layer (10) over which an etch stop layer (12) has been formed. A first dielectric layer (14) is formed over the etch stop layer (12), and a second dielectric layer (18) is formed over the first dielectric layer (14). The second dielectric layer (18) is a low k dielectric material that is spin-coated on the first dielectric layer (14). Wang et al. describe the first dielectric layer (14) as formed of a low k dielectric material with a k value of less than 4 (see col. 5, lines 32-35), and the second dielectric layer (18) also being comprised of a low k dielectric material (col. 5, lines 55). The second low k dielectric material is disclosed to require a different sensitivity than the low k dielectric material in the first dielectric layer (14) to at least one etchant chemistry (col. 5, lines 60-63), although it is not disclosed that one or the other layer needs to have the lower of the two low k values.

Wang et al., therefore, do not disclose an inorganic dielectric layer disposed over a barrier, ***the inorganic dielectric layer having a dielectric constant of about 4***, and a low dielectric constant layer disposed directly over the inorganic dielectric layer. Wang et al. do not disclose each and every feature in Applicants' independent claim 21, and therefore do not anticipate Applicants' independent claim 21, nor dependent claims 22-23 and 26-27. Applicants respectfully request this §102 rejection be withdrawn.

Claims 21-23, and 26-27 were rejected under 35 U.S.C. §102(e) as being anticipated by Smith (U.S. Patent No. 6,277,733). Applicants respectfully traverse this rejection and request reconsideration. Smith teaches a barrier (422) over a conductor (420). A low dielectric constant layer (424) is formed over the barrier (422), and a hardmask (426) is formed over the low dielectric constant layer (424). Another low dielectric constant layer (430) is formed over the hardmask (426). While the hardmask (426) may be etched for via formation, when the vias are formed, the low dielectric constant layer (430) over the etched portion is removed (Fig. 2d). Therefore, Smith

teaches a low dielectric constant layer over a hardmask over a low dielectric constant layer over a barrier over a substrate. Smith fails to teach a low dielectric constant layer disposed ***directly*** over an inorganic dielectric layer. Smith therefore fails to teach each and every feature as claimed by Applicants, and the Smith reference does not anticipate Applicants' independent claim 21, nor dependent claims 22-23 and 26-27 which depend therefrom. Applicants respectfully request this rejection be withdrawn.

Rejections under 35 U.S.C. § 103

Claims 23, 27-35, and 37-41 were rejected under 35 U.S.C. §103(a) as being unpatentable over Liu et al. in view of Zhu et al. (U.S. Patent No. 6,211,063). Applicants respectfully traverse this rejection and request reconsideration.

Claims 23 and 27-30 depend from independent claim 21. In order for claims 23 and 27-30 to be obvious, independent claim 21 would have to be obvious. Similarly, claims 37-40 depend from independent claim 36 which would also have to be obvious. As described above, Liu et al. fail to teach a low dielectric constant layer disposed directly over an inorganic dielectric layer, and fail to teach a low dielectric constant layer of a carbon-doped oxide disposed directly over an inorganic dielectric layer. Applicants further assert Liu et al. fail to suggest these features.

To establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine the reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art references when combined must teach or suggest all the claim limitations. (MPEP §2143). Applicants respectfully submit the Office has failed to establish a prima facie case of obviousness.

In independent claim 31, Applicants claim a multi-layer inter-metal dielectric semiconductor structure. The multi-layer inter-metal dielectric semiconductor structure includes a barrier layer disposed over a base dielectric layer, an inorganic dielectric layer of an un-doped TEOS oxide disposed over the barrier layer, and a low dielectric constant layer of a carbon doped oxide disposed directly over the inorganic dielectric layer. The low dielectric constant layer is configured to receive metallization line trenches and the inorganic dielectric layer is configured to receive vias during a dual-damascene process.

In independent claim 41, as amended herein, Applicants claim a multi-layer dielectric disposed over a substrate for use in dual-damascene applications. The multi-layer dielectric includes a barrier layer disposed over the substrate, an inorganic dielectric layer of a fluorine doped oxide having a first thickness disposed over the barrier layer, and a low dielectric constant layer of a carbon doped oxide having a second thickness disposed directly over the inorganic dielectric layer. A via path is configured to be defined in an entire portion of the first thickness of the inorganic dielectric layer and in at least a portion of the second thickness of the low dielectric constant layer.

As described above in reference to independent claims 21 and 36, Liu et al. fail to teach a low dielectric constant layer disposed directly over an inorganic dielectric layer, and fail to teach a low dielectric constant layer of a carbon-doped oxide disposed directly over an inorganic dielectric layer. Applicants re-assert that Liu et al. do not teach or suggest HSQ to be a carbon doped oxide as characterized by the Office.

In independent claim 31, Applicants claim an inorganic dielectric layer of an un-doped TEOS oxide disposed over the barrier layer, and again, a low dielectric constant layer of a carbon doped oxide disposed ***directly over*** the inorganic dielectric layer. While the Office recognizes that Liu et al. fail to teach or suggest an un-doped TEOS oxide, and use the Zhu et al. reference which is addressed later in this paper, the Liu et al. reference still fails to teach a low dielectric constant layer disposed ***directly over*** the inorganic dielectric layer, and fails to teach the low dielectric constant layer as being a carbon doped oxide, as described above in reference to the rejection of claims 21-24, 26, and 36.

Similarly, in independent claim 41, the inorganic dielectric layer is recited as a fluorine doped oxide. The Office fails to address this particular feature, but the Liu et al. reference teaches layer 36 is a silicate glass, and preferably a fluorinated silicate glass (col. 4, lines 13-16). However, claim 41 further recites that a low dielectric constant layer of a carbon doped oxide is disposed ***directly over*** the inorganic dielectric layer, and the Liu et al. reference fails to teach or suggest a carbon doped oxide, and fails to teach or suggest the forming of low dielectric constant layer of a carbon doped oxide ***directly over*** the inorganic dielectric layer.

As amended herein, independent claim 41 further recites a via path configured to be defined in an entire portion of the first thickness of the inorganic dielectric layer and at least a portion of

the second thickness of the low dielectric constant layer. Zhu et al. fail to teach or suggest this feature, and no additional reference in combination with Zhu et al. teaches this feature.

Applicants further note that Examiner asserts at page 5 that "Zhu et al. also teaches undoped TEOS oxide and FSG are equivalent material for the inorganic dielectric layer." Examiner sites no support for such an assertion, and it is not clear exactly what is intended by the term "equivalent material." In the sections Examiner does cite, Zhu et al. do teach that dielectric materials such as doped silicon oxide (FSG), undoped silicon oxide (SiO2), silicate glasses (BPSG, PSG), doped or undoped thermally grown silicon oxide, doped or undoped TEOS deposited silicon dioxide, etc., need to be etched in the fabrication of integrated circuits (col. 1, lines 10-18), that ***in a process for plasma etching a dielectric layer***, the dielectric layer comprises silicon oxide such as doped or undoped silicon dioxide, PBSG, PSG, TEOS, or thermal silicon oxide (col. 2, lines 20-41, emphasis added), that ***in an etching process***, doped and undoped oxide films (BPSG, PSG, TEOS) can be etched (col. 4, lines 23-24, emphasis added), and that ***the process of the invention is applicable to etching of various dielectric layers*** such as doped silicon oxide (FSG), undoped silicon oxide (BPSG, PSG), doped or undoped thermally grown silicon oxide, and doped or undoped TEOS deposited silicon oxide (col. 5, lines 9-16, emphasis added). However, Zhu et al. are teaching that the disclosed process is applicable and/or effective to the various materials. Zhu et al. are not teaching that all such materials are "equivalent," and Zhu et al. do not teach the material properties of structures fabricated using the different materials.

The combination of Liu et al. and Zhu et al. fail to teach or suggest all of the claim limitations, and therefore claims 23, 27-35, and 37-41 are not rendered obvious by the asserted combination. Further, no suggestion or motivation to combine is provided by the references themselves, nor asserted by the Office. Applicants therefore respectfully request these rejections be withdrawn.

Claims 27-30, and 41 were rejected under 35 U.S.C. §103(a) as being unpatentable over Wang et al. in view of Usami (U.S. Patent No. 6,077,574) and Huang (U.S. Patent Application Publication No. US2002/0054962). This rejection is traversed, and Applicants request reconsideration in light of claim amendments and the following argument.

As described above in reference to the §102 rejection of independent claim 21, Wang et al. essentially teach a low dielectric constant layer over a low dielectric constant layer. Wang et al.,

do not disclose an inorganic dielectric layer disposed over a barrier, ***the inorganic dielectric layer having a dielectric constant of about 4***, and a low dielectric constant layer disposed directly over the inorganic dielectric layer. Wang et al. do not disclose each and every feature in Applicants' independent claim 21. Dependent claims 27-30, depending directly or indirectly from independent claim 21, recite all of the features of independent claim 21. The Office does not assert that the combination of Wang et al. in view of Usami and Huang teach these claimed features, and Applicants maintain that the asserted combination fails to teach, or suggest, all the claim limitations as required in order to establish a *prima facie* case of obviousness. Applicants therefore request this rejection be withdrawn.

Independent claim 41, as amended herein, claims the features of a via path that is configured to be defined in an entire portion of the first thickness of the inorganic dielectric layer and in at least a portion of the second thickness of the low dielectric constant layer. The Wang et al., Usami, and Huang, references, both independently and in any combination, fail to teach or suggest these features, and therefore fail to render Applicants independent claim 41 obvious. Applicants therefore respectfully request these rejections be withdrawn.

Claims 24-41 were rejected under 35 U.S.C. §103(a) as being unpatentable over Smith in view of Usami. This rejection is traversed and Applicants request reconsideration in view of claim amendments and argument.

As described above in detail, Smith fails to teach a low dielectric constant layer disposed ***directly*** over an inorganic dielectric layer. The patent to Usami also fails to teach a low dielectric constant layer disposed ***directly*** over an inorganic dielectric layer. Further, neither Smith nor Usami teach or suggest a via path that is configured to be defined in an entire portion of the first thickness of the inorganic dielectric layer and in at least a portion of the second thickness of the low dielectric constant layer. Therefore, the combination of Smith in view of Usami fails to teach or suggest all of the claim limitations, and does not render Applicants' independent claims 21, 31, 36, or 41 obvious. Dependent claims 24-29, 32-35, and 37-40, each depending directly or indirectly from one of independent claims 31, 31, 36, and 41, are patentable for at least the same reasons. Applicants therefore respectfully request that the rejection be withdrawn.

In view of the foregoing, Applicants respectfully request reconsideration of claims 21-24 and 26-41. Applicants submit that all claims are in condition for allowance. Accordingly, a notice of allowance is respectfully requested. If Examiner has any questions concerning the present Amendment, the Examiner is kindly requested to contact the undersigned at (408) 749-6900, ext. 6905. If any additional fees are due in connection with filing this amendment, the Commissioner is also authorized to charge Deposit Account No. 50-0805 (Order No. LAM1P106D). A copy of the transmittal is enclosed for this purpose.

Respectfully submitted,
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